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Stakeholder engagement in participatory research in French marine and freshwater social-ecological systems: A systematic map protocol

Adrien Chevallier[1] | Heikel Balti[1] | Sophie Gourguet[2] | Claire Macher[2] | Yunne-Jai Shin[1] | Fabien Moullec[1,3]

[1]MARBEC, Univ Montpellier, CNRS, Ifremer, IRD, Montpellier, France

[2]Ifremer, Univ Brest, CNRS, UMR 6308, AMURE, Unité d'Economie Maritime, IUEM, Plouzané, France

[3]Department of Coastal Systems (COS), Royal Netherlands Institute for Sea Research (NIOZ), Texel, The Netherlands

Correspondence
Fabien Moullec
Email: fabien.moullec@umontpellier.fr

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Abstract

1. Stakeholder engagement (SkE) in research is currently experiencing significant growth within the fields of environmental and sustainability sciences. Stakeholder engagement ensures the relevance of research questions to societal expectations and the uptake and salience of the co-produced knowledge and results for their use in the decision-making process.
2. In a context of societal challenges regarding biodiversity conservation and the sustainability of marine and freshwater social-ecological systems (SESs), participatory approaches constitute key methods in applied research involving actions and decision-making. There are, however, many gaps in the practical, conceptual and ethical ways stakeholders have been involved in research.
3. We propose here a systematic map of the literature on SkE in research on marine and aquatic SESs carried out on French European and overseas territories, in order to draw up the first comprehensive overview of how SkE has developed and changed since 1945.
4. This systematic map will identify a representative list of scientific articles on SkE in French marine and freshwater social-ecological research. The literature search will include both academic literature (e.g. peer-reviewed articles, reviews, meta-analyses) and grey literature (e.g. reports, working papers) using the most relevant search engines for the scientific literature published between 1945 and 2023. Retrieved publications will be reviewed for relevance according to a predefined set of eligibility/ineligibility criteria by a group of trained reviewers. The eligibility check will be done in two successive screening steps: (1) title and abstract and (2) full text, each independently performed by two reviewers. All retained literature will be subjected to coding and metadata extraction using the Sysrev platform. No validity assessment will be undertaken. A database of the metadata extracted

Adrien Chevallier and Heikel Balti—Co-first authors.

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will be provided, along with a narrative description of the evidence base, and a set of figures and tables summarizing the relevant characteristics of the studies.
5. This systematic map will provide a reliable overview of SkE conducted in research projects on French aquatic social-ecological systems to strengthen the science–society relationship and help future research projects implement efficient and sustainable SkE processes in France and elsewhere.

KEYWORDS
aquatic, participatory approach, research gap, research trend, stakeholder involvement, sustainability science, transdisciplinary

1 | INTRODUCTION

Human-induced global changes (i.e. land and sea use changes, exploitation of natural resources, climate change, pollutions and biological invasions) impact, directly or indirectly, terrestrial and aquatic social-ecological systems (SESs) at both local and global scales, through biodiversity loss and deterioration of ecosystem services (Cardinale et al., 2012; Folke et al., 2021; IPBES, 2019; IPCC, 2022). Since the 1970s, anthropogenic impacts have sharply increased due to the demand for goods and services from a growing population and an increasing average per capita income, jeopardizing the capacity of ecological systems to sustain human well-being (e.g. health care, social equity, food security) in the coming decades (Diaz et al., 2019; Jaureguiberry et al., 2022).

Aquatic SESs (i.e. marine and freshwater systems) are facing cumulative impacts and the biodiversity they host is declining at a faster rate than in most terrestrial systems (Vaughn, 2010): 93% of Europe's regional seas are subject to multiple anthropogenic pressures (e.g. overexploitation, pollution; Korpinen et al., 2019) and European freshwater ecosystems (e.g. flowing waters, lakes) are facing environmental problems such as pollution, eutrophication and hydro-morphological deterioration (Costa et al., 2021; Dudgeon, 2019; Fluet-Chouinard et al., 2023). Pressures on these SESs are intrinsically complex, and their management will most often involve trade-offs as they interact with a multitude of environmental and human systems and operate at various scales in time and space (Folke et al., 2021; Mace et al., 2014). Environmental managers face, therefore, a complex set of environmental, cultural, social, economic, political and governance concerns (Brooks et al., 2013). To inform conservation policies and contribute to implement an ecosystem-based management, scientists should tackle the difficult challenge of integrating natural and social sciences into common research efforts, and develop a transdisciplinary research, that is, a research that involves academic researchers from different disciplines and sub-disciplines as well as non-academic participants to address a common research question through novel knowledge production and theory (e.g. Edrisi & Abhilash, 2021; Kiatkoski Kim et al., 2022; Lang et al., 2012; Macher et al., 2018, 2021; Maxwell & Benneworth, 2018; Sievanen et al., 2012; Strand et al., 2022; Tress et al., 2005). In an ecosystem-based management context, especially for aquatic SESs, it is increasingly recognized that science needs to engage stakeholders in research projects (see Box 1 for definitions of stakeholder and stakeholder engagement) to account for their knowledge, perceptions and preferences and thus improve the effective use of science programmes for decision-making (Cvitanovic et al., 2015, 2016; Lavery, 2018; Mackinson et al., 2011; Röckmann et al., 2012; Talley et al., 2016). Singh et al. (2021) stated, 'To

BOX 1 Stakeholder and stakeholder engagement definitions

Stakeholders are defined as natural or legal persons that have a 'stake' in one or more target issues and who can be called upon during processes of interest (e.g. policymakers, funding agencies, non-governmental organizations, natural resource managers, end-users) (Durham et al., 2014; Roque et al., 2022). In other words, stakeholders are any individuals, groups or organizations who affect, or could be affected (whether positively or negatively) by a particular issue and its associated policies, decisions and action (Ballesteros & Dickey-Collas, 2023; Chevalier & Buckles, 2019).

Stakeholder engagement refers to the active involvement and participation of stakeholders in a research project (Vaughn & Jacquez, 2020). Three main levels of SkE can be identified in the literature and ranked in ascending order (Arnstein, 1969; Durham et al., 2014; Vaughn & Jacquez, 2020): (1) information, when the research team shares information about the project or provides results to stakeholders, (2) consultation, when stakeholders are invited to provide information or feedback that researchers take into account during the process of making research-related choices and (3) collaboration, when stakeholders are directly involved in co-constructing the research project through a partnership with researchers, starting from the proposal formulation stage towards different levels of involvement in the decision-making process for the project.

achieve the ocean we want, we must better understand the needs and priorities of ocean-dependent peoples and evaluate potential solutions for them'. We could even argue that to build a shared representation of aquatic systems and to explore common future and solutions, we need to share and integrate all the academic and non-academic sources of knowledge.

Strong participation of the society, through stakeholder engagement (SkE), allows to generate useful knowledge that may lead to more efficient and sustainable positive outcomes (e.g. by improving the translation of scientific findings into policy or practice and providing solution-oriented science) and increase the acceptance of scientific findings and decision-making by the various users and beneficiaries of aquatic SESs (Beierle, 2002; Durham et al., 2014; Fischer, 2000; Lavery, 2018; Silvano et al., 2023; Stringer et al., 2007). In addition, it is now recognized that SkE reinforces the credibility, legitimacy and saliency of cross-boundary organizations operating at the science-policy interface, especially in the biodiversity conservation and natural resources management domains (Ballesteros & Dickey-Collas, 2023; Conallin et al., 2017; Pomeroy & Douvere, 2008; Reed, 2008; Sterling et al., 2017). Stakeholder engagement is part of the so-called participatory research, which is based on the principles of social justice, democratization of knowledge production and access, and recognizes that participants in scientific studies can play the roles of both research subjects and actors directly involved in the research process (Roque et al., 2022). Participatory research promotes research 'with' individuals and communities to form, norm and/or make decisions that affect them (Ballesteros & Dickey-Collas, 2023; Reed, 2008), and not only 'on', 'about' or 'for' them (Macaulay, 2017). To support transition and social transformation, we need to explore new research approaches based on SkE. Stakeholder engagement has been developed to address the many issues raised by natural resource management and biodiversity conversation. Introduced in the 1970s, SkE has been used extensively since the 1990s, particularly in the fields of agricultural and natural resource management research (Johnson et al., 2004) but is also used in many other research fields, including aquatic ecology (Schwermer et al., 2020). Stakeholder engagement provides social links between researchers and the broader society, involves people in research processes and aims to create public involvement (Houllier & Merilhou-Goudard, 2016; Roque et al., 2022). The implementation of this approach promotes that research projects meet societal expectations and that their results are used by decision-makers (Durham et al., 2014; Jagosh et al., 2012).

The number of publications that focus on SkE has increased drastically over the last 20 years, notably in management-oriented areas of science (Schwermer et al., 2020; Voinov & Bousquet, 2010). 'Stakeholder engagement', 'collaboration' or 'participation' have become very compelling buzzwords in research project proposals (Berghöfer et al., 2008; Voinov & Bousquet, 2010). One of the reasons is that funding agencies from the public or private sectors at national or international levels increasingly require or encourage that environmental research projects engage multiple stakeholders to produce meaningful and responsible research and align it with societal values and needs (Ballesteros & Dickey-Collas, 2023; Durham et al., 2014; ICES, 2023a; Robinson et al., 2021). Another important reason of this development is that there is a growing concern in the international arena, for instance through the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) or the Food and Agriculture Organization of the United Nations (FAO), for recognizing the importance of Indigenous and Local Knowledge (ILK) through the participation of Indigenous peoples and local communities to the assessment, conservation and sustainable use of socio-ecosystems (Fischer et al., 2015; IPBES, 2017). There are, however, many gaps in the practical, theoretical and ethical ways stakeholders have been involved in research projects (Berghöfer et al., 2008; Norström et al., 2020; Schwermer et al., 2020; Silvano et al., 2023; Villamor et al., 2022). Stakeholders' perceptions of their participation in the research process often diverge from those of scientists (Pita et al., 2010). For Berghöfer et al. (2008), stakeholders' participation 'is at least as popular, officially promoted and ambiguous as ecosystem management' while for Voinov and Bousquet (2010) 'in far too many cases stakeholders have merely been paid lip service and their engagement has consequentially been quite nominal'. In the same vein, Cornwall and Jewkes (1995) wrote 'Much of what passes as participatory research goes no further than contracting people into projects which are entirely scientist-led, designed and managed'. Many research projects do not secure enough funds or time to efficiently engage with stakeholders, do not build on what has been learned in social sciences and/or do not develop a strategic and tokenistic approach to identify, contact, engage and maintain engagement with stakeholders (and their interest) over time (Barreteau et al., 2010; ICES, 2021, 2023a; Schwermer et al., 2020). In addition, the evaluation of SkE in participatory processes is often extremely limited (Bowen et al., 2017).

To reinforce and improve the relevance of SkE processes in research projects, there is a need to review and assess the existing scientific corpus on the topic. By categorizing and analysing the available studies, a systematic map can pinpoint areas where research is lacking or where specific aspects of a topic need further investigation. This can also inform the design of new research projects and researchers can build upon existing studies and identify best practices, successful interventions, and effective methodologies. To our knowledge, no previous study has analysed and synthetized how SkE has evolved in research on aquatic SESs. To fill this gap in SkE research, unfold its full potential and inspire future developments, we will perform a systematic map on the SkE approaches conducted in research projects on French aquatic SESs. France, with its European and overseas territories (i.e. territories remote from the European continent that are under the jurisdiction or sovereignty of France), is a coastal State that constitutes a particularly relevant case study. With a total area of ca. 10.7 million km^2, it represents the world's second largest maritime space (after that of the United States) and is neighbouring almost all oceans over a wide range of latitudes. It also hosts a great diversity of aquatic ecosystems (from temperate salt marshes to tropical coral reefs).

1.1 | Objectives of the systematic map

A systematic map is well-suited when dealing with a broad and diverse range of evidence, especially when the available literature spans various disciplines, methodologies and contexts (James et al., 2016). By categorizing and characterizing studies based on their methodologies, themes and geographic locations, a systematic map provides a comprehensive overview of the existing evidence. This approach facilitates the identification of research gaps, trends and patterns, enabling researchers and policymakers to make more informed decisions about where further investigation or intervention might be needed (Collaboration for Environmental Evidence, 2022; Grant & Booth, 2009; James et al., 2016). A systematic map is particularly well-suited when the research question of the review is open-framed, as it is the case in this study (Collaboration for Environmental Evidence, 2022). The main objective of our systematic map is to provide a comprehensive overview of approaches that were conducted in scientific research projects on French (i.e. in European and overseas France) aquatic SESs (e.g. marine and coastal areas, estuaries, rivers) between 1945 and 2023. To do so, we will:

1. provide an exhaustive panorama of the level of engagement related to the research projects (e.g. information, consultation, collaboration), the types of intention for participation declared (Schwermer et al., 2020) and the participation tools used (e.g. semi-structured interview, focus group, survey, participatory modelling);
2. identify stakeholder types (e.g. manager, policy maker, scientist, users, NGO sensu Jolibert and Wesselink (2012)), the definitions and the methods used to determine which stakeholder to engage (Reed et al., 2009);
3. identify the geographical locations and the ecosystem types where SkE approaches were conducted;
4. present the general contexts, topics, and research questions that required SkE;
5. highlight potential knowledge gaps, best practices, and future methodological scientific and societal challenges to effectively and actively engage stakeholders in scientific research projects.

1.2 | Primary research question

The primary research question of this study is: How has SkE in French aquatic SESs research evolved over the last decades?

The primary question is defined using the PICO format: Population, Intervention, Comparator and Outcome as described in Haddaway et al. (2018):

- *Population*: Research on the French aquatic SESs, including marine (i.e. inshore and offshore waters) and freshwater (e.g. lakes, rivers, wetlands) environments. We will consider exclusively aquatic SESs, as considering participatory approaches implemented to all types of SESs would be too extensive in terms of the number of academic studies and grey literature to be included in our systematic map, and too disparate in terms of the interdisciplinary expertise required to carry it out. For instance, on a worldwide scale but on limited samples of studies, Gerlak et al. (2023) listed the following environmental research themes where SkE has been found: food and agriculture, land and soil conservation, forests, water, marine ecosystems and coasts, wildlife and biodiversity, climate, urban planning and development, and energy. In our case, all the academic and grey literatures will be analysed by a team having expertise in participatory research, biodiversity conservation, climate science, sociology and economics applied to aquatic SESs.
- *Intervention*: All participatory approaches explicitly engaging stakeholders in the research process will be considered relevant interventions. They exclusively include two-way communication and range from consultation to the highest level of collaboration, where stakeholders are involved in decision-making throughout the research process (Jolibert & Wesselink, 2012; Vaughn & Jacquez, 2020). Information process, considered as 'traditional research outreach' and as the lowest level of SkE (Vaughn & Jacquez, 2020), will not be covered by our review. Indeed, many research works include informal outreach, does not take feedback into account and/or do not specifically target stakeholders but the general public, which implies that works relevant to this low level of SkE are not likely to be targeted by our search strings (Merlino et al., 2015). In the same way, citizen science (i.e. the process by which citizens are involved in science as researchers, mostly for data collection) will be not considered here as SkE and thus as participatory research, because citizens participating in these research projects are usually not consulted or directly involved in the decision-making process (Göbel et al., 2019; Silvertown, 2009). Hence, we will exclude articles dealing only with citizen sciences, unless they explicitly mention a two-way communication process involving stakeholders.
- *Comparator*: Studies will not be required stricto sensu to have a comparator.
- *Outcome*: There are no predefined outcomes. All outcomes will be potentially relevant as long as they describe SkE in research areas related to French aquatic SESs.

1.3 | Secondary research questions

Subsidiary to the primary question, the systematic map will answer the following secondary research questions:

1. Which research topics have mobilized stakeholders?
2. How diverse are the participatory approaches and SkE processes in research on French aquatic SESs?
3. Can we evaluate the effectiveness of SkE approaches and provide recommendations for future research?
4. Can we identify differences in approaches between marine and freshwater SESs?

5. What are the strengths, shortcomings, and gaps that we can identify concerning the identified SkE approaches?

2 | MATERIALS AND METHODS

The method used to generate the systematic map will conform to the Collaboration for Environmental Evidence (CEE) Guidelines and Standards for Evidence Synthesis in Environmental Management (Collaboration for Environmental Evidence, 2022). In addition, the paper adheres to the RepOrting standards for Systematic Evidence Syntheses (ROSES, see Appendix S1 for our declaration and checklist of adherence to the ROSES guidelines) (Haddaway et al., 2018).

2.1 | Searching for articles

Our search strategy is designed to retrieve a broad range of articles covering the topic of SkE developed for aquatic SESs and carried out in European and overseas France. We will include in the systematic map all scientific articles (including primary research articles, reviews, proceeding papers, books, and book chapters) and grey literature (i.e. theses, non-commercial publications such as reports) produced on the topic from 1945 to 2023 (included).

2.1.1 | Scoping

A scoping exercise in the Web of Science (WoS) Core Collection database was conducted to build a relevant search string, using terms describing the population (i.e. aquatic SESs research), the interventions (i.e. SkE) and the location (i.e. all French territories). The English search string (Table 1) yielded 5025 articles in WoS and 4763 articles in Scopus, while the French search string (Table 2) retrieved 5030 and 7112 articles in WoS and Scopus, respectively. A test-list of 30 benchmark articles (Appendix S2), written both in English and French and considered as particularly relevant to the research question, was defined by the study team to develop the search string and assess the comprehensiveness of the search (Booth et al., 2021). All their keywords along with relevant words and expressions in their title and abstract were extracted to develop the search string. Subsequently, two thesaurus dictionaries (www.thesaurus.com and https://skosmos.loterre.fr/en/) and the artificial intelligence program ChatGPT (OpenAI, 2021) were used to identify all appropriate synonyms, thereby improving the generality and specificity of the search.

2.1.2 | Language of the search

It was demonstrated that researchers from social sciences and humanities tended to publish in their local languages (French in our case) rather than in English (Kulczycki et al., 2020). Indeed, Sivertsen (2018) argued that local language used in scholarship is needed to foster engagement with stakeholders. To avoid missing key articles and introducing biases due to a monolingual search (Nuñez & Amano, 2021), searches will be performed using both English and French terms. All relevant international and national literature published in English and/or French will be included in this systematic map. Studies identified via the English search strings but published in other languages (e.g. Spanish or local dialects) will not be screened for inclusion.

2.1.3 | Search terms

English and the French search strings (Tables 1 and 2) were iteratively developed over several rounds of discussion between all authors. They are composed of three sub-strings that match with the key elements of the primary research question. The search terms used for the sub-string on the Intervention part (sub-string 1) include different keywords associated with SkE and have already been used in three literature reviews investigating SkE in SESs (Grünhagen et al., 2022; Schwermer et al., 2020; Sterling et al., 2017). The search terms used for the Population part is composed of keywords related to the aquatic realms in France (sub-string 2a) and of keywords defining the French territories (i.e. European and overseas territories and main seas and rivers) (sub-string 2b).

Both French and English search strings were built around those three sub-strings (the French search string is a simple translation of the English one). The asterisk (*) and the dollar sign ($), acting as wildcards, were used to expand some search terms, thus maximizing our search results.

The three sub-strings will be combined with the 'AND' Boolean operator. Searches will be conducted in the title, abstract and author keyword fields, taking into account the specificities of each bibliographic database (i.e. using, for instance, the search tags 'TS' in Web of Science Core Collection (the 'keyword plus' field is used by default), 'TITLE-ABS-KEY' in Scopus and '[Title/Abstract]' in PubMed, and replacing the dollar sign ($) by the question mark (?) in Scopus). The search strategy will also be adapted for each search engine (e.g. in the Publish or Perish software for Google Scholar).

2.1.4 | Comprehensiveness of search

A test-list of 30 benchmark articles (Appendix S2), covering different types of SkE approaches and aquatic ecosystems and meeting the various inclusion criteria, was compiled by the study team (completed on 30/01/2023). The benchmark list was used to test each search in the Web of Science Core Collection and Scopus and check whether the English search string is relevant to bring up all of the benchmark articles. After few adjustments, by adding, for instance, some maritime areas surrounding France (e.g. 'Bay of Biscay') or

TABLE 1 English search terms constituting the English search string.

Sub-string	Search terms
Sub-string 1	(participa* OR transdisciplinar* OR "trans-disciplinar*" OR stakeholder$ OR partner* OR engagement OR involvement OR consult* OR collaborat* OR coproduc* OR "co-produc*" OR "community-based" OR "community based")
Sub-string 2a	(aquatic OR water$ OR freshwater$ OR "fresh-water$" OR ocean* OR marine OR maritime OR pelag* OR benth* OR demersal OR littoral OR coast* OR bay OR embayment OR gulf$ OR wetland$ OR "sea$" OR seashore OR shore* OR offshore OR dam$ OR lake$ OR river* OR stream$ OR fluvial OR pond$ OR pool$ OR marsh* OR saltmarsh* OR "salt marsh*" OR lagoon$ OR estuar* OR coral$ OR mangrove$ OR delta$)
Sub-string 2b	(France OR French OR Ain OR Aisne OR Allier OR "Alpes-de-Haute-Provence" OR "Hautes-Alpes" OR "Alpes-Maritimes" OR Ardèche OR Ardennes OR Ariège OR Aube OR Aude OR Aveyron OR "Bouches-du-Rhône" OR Calvados OR Cantal OR Charente OR "Charente-Maritime" OR Cher OR Corrèze OR "Corse-du-Sud" OR "Haute-Corse" OR Corse OR "Côte-d'Or" OR "Côtes d'Armor" OR Creuse OR Dordogne OR Doubs OR Drôme OR Eure OR "Eure-et-Loir" OR Finistère OR Gard OR "Haute-Garonne" OR Gers OR Gironde OR Hérault OR "Ille-et-Vilaine" OR Indre OR "Indre-et-Loire" OR Isère OR Jura OR Landes OR "Loir-et-Cher" OR Loire OR "Haute-Loire" OR "Loire-Atlantique" OR Loiret OR Lot OR "Lot-et-Garonne" OR Lozère OR "Maine-et-Loire" OR Manche OR Marne OR "Haute-Marne" OR Mayenne OR "Meurthe-et-Moselle" OR Meuse OR Morbihan OR Moselle OR Nièvre OR Nord OR Oise OR Orne OR "Pas-de-Calais" OR "Puy-de-Dôme" OR "Pyrénées-Atlantiques" OR "Hautes-Pyrénées" OR "Pyrénées-Orientales" OR "Bas-Rhin" OR "Haut-Rhin" OR Rhône OR "Haute-Saône" OR "Saône-et-Loire" OR Sarthe OR Savoie OR "Haute-Savoie" OR Paris OR "Seine-Maritime" OR "Seine-et-Marne" OR Yvelines OR "Deux-Sèvres" OR Somme OR Tarn OR "Tarn-et-Garonne" OR Var OR Vaucluse OR Vendée OR Vienne OR "Haute-Vienne" OR Vosges OR Yonne OR "Territoire de Belfort" OR Essonne OR "Hauts-de-Seine" OR "Seine-Saint-Denis" OR "Val-de-Marne" OR "Val-d'Oise" OR Guadeloupe OR Martinique OR "French Guiana" OR Reunion OR Mayotte OR "Saint Barthelemy" OR "Saint Martin" OR "Saint Pierre and Miquelon" OR "Wallis and Futuna" OR "New Caledonia" OR "French Polynesia" OR "Bay of Biscay" OR "English Channel" OR "Gulf of Lion$" OR Seine OR Rhône OR Garonne OR Rhine OR Pertuis)

major rivers (e.g. 'Garonne'), the English search string was able to capture 93% of the benchmark articles indexed in Web of Science and Scopus. Over the 30 benchmark articles, the two articles not retrieved by WoS and Scopus did not contain any keyword associated with a French territory in their title/abstract/keywords fields. One option would be to remove the sub-string specifying the French territories but the search key would identify too many (irrelevant) articles (ca. 304,904 articles found in WoS with the English search string) rendering the screening process unmanageable. The final performance of our search strategy (i.e. the percentage of the benchmark list finally retrieved by the search strategy when applied to all bibliographic sources) will be reported in the final systematic map.

2.1.5 | Bibliographic databases

Our systematic map will explore a large variety of multidisciplinary and discipline-specific databases and platforms:

- Web of Science Core Collection on the Web of Science platform (Clarivate) using the access rights provided by the University of Montpellier. The search covered SCI-EXPANDED, SSCI, AHCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI and CCR-EXPANDED. Web of Science is a multidisciplinary database that covers a wide range of scientific disciplines such as natural and social sciences.
- Scopus (Elsevier) using the access rights brought by Université de Bretagne Occidentale. Scopus is known for its extensive coverage of scientific literature, encompassing a wide range of disciplines and sources.
- PubMed (https://pubmed.ncbi.nlm.nih.gov/) using the access rights provided by the University of Montpellier. PubMed includes a vast collection of journals related to natural sciences.
- Aquatic Sciences and Fisheries Abstracts (ASFA) (https://www.fao.org/fishery/en/global-search?q=asfa%20en&lang=en), a database on aquatic resources (https://www.fao.org/fishery/en/openasfa) that we will consult using the access rights of the Institut Français de Recherche pour l'Exploitation de la Mer

TABLE 2 French search terms constituting the French search key.

Sub-string	Search terms
Sub-string 1	(participa* OR transdisciplina* OR "trans-disciplina*" OR "partie* prenante*" OR partena* OR acteur$ OR engagement OR implication OR consult* OR concerta* OR concerte* OR coprodu* OR "co-produ*")
Sub-string 2a	(aquatique$ OR eau$ OR dulcicole$ OR dulçaquicole$ OR océan* OR marin* OR maritime$ OR littora* OR côtier* OR p$lag* OR benth* OR démersa* OR baie$ OR embouchure$ OR golfe$ OR "zone* humide*" OR mer$ OR rive$ OR rivage$ OR barrage$ OR lac* OR rivière$ OR ruisseau$ OR fleuve$ OR étang$ OR bassin$ OR marais OR marécage* OR "prés salé$" OR vasière$ OR lagon$ OR lagun* OR estuaire$ OR coraux OR coralli$ OR mangrove$ OR delta$)
Sub-string 2b	(France OR Français* OR Ain OR Aisne OR Allier OR "Alpes-de-Haute-Provence" OR "Hautes-Alpes" OR "Alpes-Maritimes" OR Ardèche OR Ardennes OR Ariège OR Aube OR Aude OR Aveyron OR "Bouches-du-Rhône" OR Calvados OR Cantal OR Charente OR "Charente-Maritime" OR Cher OR Corrèze OR "Corse-du-Sud" OR "Haute-Corse" OR Corse OR "Côte-d'Or" OR "Côtes d'Armor" OR Creuse OR Dordogne OR Doubs OR Drôme OR Eure OR "Eure-et-Loir" OR Finistère OR Gard OR "Haute-Garonne" OR Gers OR Gironde OR Hérault OR "Ille-et-Vilaine" OR Indre OR "Indre-et-Loire" OR Isère OR Jura OR Landes OR "Loir-et-Cher" OR Loire OR "Haute-Loire" OR "Loire-Atlantique" OR Loiret OR Lot OR "Lot-et-Garonne" OR Lozère OR "Maine-et-Loire" OR Manche OR Marne OR "Haute-Marne" OR Mayenne OR "Meurthe-et-Moselle" OR Meuse OR Morbihan OR Moselle OR Nièvre OR Nord OR Oise OR Orne OR "Pas-de-Calais" OR "Puy-de-Dôme" OR "Pyrénées-Atlantiques" OR "Hautes-Pyrénées" OR "Pyrénées-Orientales" OR "Bas-Rhin" OR "Haut-Rhin" OR Rhône OR "Haute-Saône" OR "Saône-et-Loire" OR Sarthe OR Savoie OR "Haute-Savoie" OR Paris OR "Seine-Maritime" OR "Seine-et-Marne" OR Yvelines OR "Deux-Sèvres" OR Somme OR Tarn OR "Tarn-et-Garonne" OR Var OR Vaucluse OR Vendée OR Vienne OR "Haute-Vienne" OR Vosges OR Yonne OR "Territoire de Belfort" OR Essonne OR "Hauts-de-Seine" OR "Seine-Saint-Denis" OR "Val-de-Marne" OR "Val-d'Oise" OR Guadeloupe OR Martinique OR Guyane OR Réunion OR Mayotte OR "Saint Barthelemy" OR "Saint Martin" OR "Saint Pierre et Miquelon" OR "Wallis et Futuna" OR "Nouvelle Calédonie" OR "Polynésie Française" OR "golfe de Gascogne" OR "golfe du Lion" OR Seine OR Rhône OR Garonne OR Rhin or Pertuis)

(IFREMER). ASFA is recognized as a highly relevant database for aquatic science grey literature (Castillo et al., 2023). The database will be accessed through the Earth, Atmospheric & Aquatic Science Collection via ProQuest.

- AquaDocs (https://aquadocs.org/), an open access repository of the UNESCO/IOC International Oceanographic Data and Information Exchange (IODE) and the International Marine and Aquatic Sciences Libraries and Information Centers (IAMSLIC) with support from the FAO Aquatic Sciences and Fisheries Abstracts.
- BioOne Complete (https://complete.bioone.org/), a database of more than 200 subscribed and open-access titles in the biological, ecological and environmental sciences.
- Archimer (https://archimer.ifremer.fr/), a French open access database on sea and ocean studies.
- HAL (https://hal.archives-ouvertes.fr/), an open archive where authors can deposit articles from all academic fields.
- SAGE journals (https://journals.sagepub.com/) using the access rights provided by the University of Montpellier. SAGE offers a diverse portfolio of journals, each specializing in different areas of natural and social sciences.
- Journal Storage (JSTOR) (https://www.jstor.org/) using the access rights provided by the University of Montpellier. JSTOR is a multidisciplinary database which includes journals from fields like biology, ecology and environmental studies.
- Wiley online library (https://onlinelibrary.wiley.com/) using the access rights provided by the University of Montpellier. Wiley offers a wide range of scholarly journals and publications across various disciplines, including social and environmental sciences.
- CAIRN (https://www.cairn.info/), an online collection of francophone publications in social sciences and humanities.

2.1.6 | Grey literature searches

To complement previous databases already encompassing grey literature, we will use the search engine Google Scholar (Haddaway et al., 2015) via the Publish or Perish 7 software program (Harzing, 2007) to query the first top 1000 relevant results (Haddaway et al., 2015). Titles only ('Title words' field) will be used to search for literature on Google Scholar. As with database searches,

we will conduct our searches in English and French over the period 1945 to 2023 (included).

To do this, the terms used will be related to our Population (i.e. French aquatic SESs) and Interventions (i.e. SkE). Due to character limitation (256-character limit in Google Scholar), simplified English and French search strings derived from the ones used for the bibliographic databases, will be used (Table 3). Search results will be sorted in the same order in which the standard Google Scholar engine returns them ('rank' function in Publish or Perish).

Searches of the grey literature will be expanded using the online search engines BASE (Bielefeld Academic Search Engine; https://www.base-search.net/) and CORE (https://core.ac.uk/). The first 300 results, published between 1945 and 2023, will be included for screening.

2.1.7 | Organizational websites

The following organizational websites (Table 5) will be searched using one of the following terms in english {'stakeholder'; 'participatory approach'} or in french {'parties prenantes'; 'acteurs'; 'approches participatives'; 'consultation'} in conjunction with the term 'France':

- CBD, Convention on Biological Diversity (CBD, 2023).
- WWF France, World Wildlife Fund (WWF, 2023).
- OFB, French Office for Biodiversity (OFB, 2023).
- CNPMEM, Comité national des pêches maritimes et des élevages marins (CNPMEM, 2023).
- ONF, Office national des Forêts (ONF, 2023).
- EEA, European Environment Agency (EEA, 2023).
- ICES, International Council for the Exploration of the Sea (ICES, 2023b).
- FAO, Food and Agriculture Organization of the United Nations (FAO, 2023).

2.1.8 | Supplementary searches

To improve the comprehensiveness of the search, the bibliographic references contained in the test-list of benchmark articles will be extracted and included for screening, using the snow-balling method (Wohlin et al., 2022).

2.1.9 | Search update

A search update will only be undertaken if the systematic map is completed one year after original searches. In this case, the whole search strategy will be repeated using the same search string but restricting to the time period after the original searches were performed. The same systematic map protocol will be respected for the newly added articles.

TABLE 3 English and French search strings for grey literature searches on Google Scholar via the Publish or Perish software.

	'Title words' field	French territories
English search string	(stakeholder OR participatory OR engagement OR involvement OR partnership OR consultation) AND (aquatic OR freshwater OR marine) AND [one of the French territories]	France French Guadeloupe Martinique French Guiana Reunion Mayotte Polynesia 'Saint Barthelemy' 'Saint Martin' 'Saint Pierre and Miquelon' 'Wallis and Futuna' 'New Caledonia'
French search string	("parties prenantes" OR participative OR engagement OR implication OR partenariat OR consultation OR enquête) AND (aquatique OR eaux OR marin OR océan) AND [one of the French territories]	France Français Antilles Guadeloupe Martinique Guyane Réunion Mayotte Polynésie 'Saint Barthélemy' 'Saint Martin' 'Saint Pierre et Miquelon' 'Wallis et Futuna' 'Nouvelle Calédonie'

Note: Note that Publish or Perish returns the exact matches only (e.g. 'stakeholder' does not match 'stakeholders').

2.2 | Article screening and eligibility criteria

2.2.1 | Screening process

After duplicate removal and check for potential retracted articles under the free reference management software Zotero, the article selection process will be conducted using the online platform SysRev (https://sysrev.com/) which allows for collaborative document review and automated data extraction (Bozada et al., 2021). The article screening phase will first be conducted on the titles and abstracts and then on the full texts. The full-text assessment will take place during the process of data extraction. A list of articles that were not retained at the full text stage and the reasons for their exclusion will be provided.

2.2.2 | Consistency checking

Before starting the screening process independently, reviewers will follow a few training sessions with different subsets of 30 random articles from our corpus. They will review a first set of 30 titles and abstracts of scientific articles to ensure consistency as in (Moullec et al., 2021). The consistency rates will be calculated using the Fleiss' kappa index (K), which must be equal to or greater than 0.6, to represent substantial or near perfect agreement (Landis & Koch, 1977). In case of an index below 0.6 (i.e. if there is a difference of opinion), discrepancies will be discussed by all reviewers, and the training session will be repeated with a new set of 30 articles, and that, until the threshold value of 0.6 is reached. Once the inclusion and exclusion criteria are fully understood by all reviewers, the screening of titles and abstracts will begin. However, if some disagreements still remain between the reviewers regarding the eligibility criteria, the review team will meet to resolve them and will eventually redefine these criteria. Each article will be reviewed by two reviewers to ensure consistency. If there is a discrepancy between them, the final decision will be discussed by two additional reviewers to resolve all conflicts. If the qualifying information is not detailed enough to reject or retain an article with certainty, the article in question will be reviewed by two additional reviewers. At each stage of the screening process, we will ensure that reviewers will never have to screen their own authored articles.

2.2.3 | Eligibility criteria

The inclusion and exclusion criteria (Table 4) will be applied at both title/abstract and full-text stages of the screening process. A conservative approach in respect of our eligibility criteria will be undertaken between the title/abstract screening and full-text screening stages. The relevance of an article will be assessed according to the criteria displayed in Table 4.

2.3 | Study validity

We only intend to collect descriptive information. As there will be no synthesis of results, no critical appraisal of study will be performed for this map. We will nevertheless collect information on study designs (e.g. type of stakeholders, definitions provided to define the stakeholders, type of intention for participation and participation tools conducted, and ways they were implemented) that may provide some preliminary information of internal validity.

2.4 | Data coding strategy

The coding strategy aims to answer the primary and secondary questions. The strategy relied in particular on Durham et al. (2014), which identifies several levels of SkE, and on Schwermer et al. (2020), which identifies several intentions for participation and different methods used. Data coding and meta-data extraction will be undertaken for all relevant studies by two reviewers. These reviewers will code the full text and extract the relevant information (Table 5). The applicability and efficiency of the meta-data form will be tested on a subsample of 10 articles coming from the title/abstract screening phase. For each category, a missing information will be marked as 'Not specified'. If resources allow, we may contact the authors to request the missing information. Results will be extracted as .csv file in a 'long' format (one row corresponding to one participatory approach type described per article (i.e. 'Intention for participation type' (n) in Table 5)) (Haddaway et al., 2021). This 'long' format will facilitate the envisaged data analysis, the filtering of the database and will be easily converted to a 'wide' format if necessary (Haddaway et al., 2021). As a single article can describe several SkE approaches and tools, each article will be given a unique identifier. Several categories of data will be extracted (Table 5).

2.5 | Study mapping and presentation

The final systematic map report will include as supplementary information a ROSES pro format and a flow diagram specifically designed for systematic maps in the field of environmental management (Haddaway et al., 2018) as well as a publicly accessible mapping database. This database will detail all selected scientific articles and their coded data. Descriptive statistics, tables and figures (i.e. heat maps and alluvial plots) will describe how SkE has evolved in French aquatic SESs research over the last decades. Heat maps will be created to identify where (French territories), when (year), how (participatory approach used) and who (stakeholder type) has been engaged in scientific research on SESs in France. These heat maps will help to identify knowledge clusters and gaps. The results of the map will also allow to identify research projects (and project leaders) that have mobilized SkE approaches

TABLE 4 Inclusion and exclusion criteria.

Categories	Inclusion criteria	Exclusion criteria
Population (s)	All studies related to aquatic SESs (from freshwater to marine ecosystems) including some man-made structured such as dams	All studies exclusively related to terrestrial SESs. Aquifer systems and glaciers will not be considered as aquatic ecosystems in this systematic map
	Case studies are located (at least partially) in France in its European and/or overseas territories (i.e. overseas regions, departments, collectivities, and *sui generis* collectivity)	All studies conducted exclusively outside French European and overseas territories and which do not focus on a French activity (e.g. a French fishing fleet)
	Case studies are based on French activities (e.g. fisheries) not necessarily operating in French territories (e.g. a French fishing fleet operating outside the French exclusive economic zone)	
Intervention(s)	All articles based on a participatory approach and explicitly engaging with stakeholders through two-way communication	All research that do not engage any stakeholder, engage with only unilateral information or just mention stakeholders without any explicit engagement (e.g. sentences written in an abstract such as 'this study will be most useful for stakeholders') Citizen sciences are not considered as a participatory approach in this systematic map, unless the corresponding articles explicitly mentioned a two-way communication process involving stakeholders
Outcome(s)	The study describes a participatory approach or analyse results from a participatory approach	
Study designs	All study designs will be included (primary research article, thesis, report, proceeding paper, review, meta-analysis, book and book chapter) Articles must be published between 1945 and 2023	Methodological papers in which SkE approaches are not explicitly applied to a French SES Posters, conference abstracts, presentations, editorial materials, letters and data paper will be considered as irrelevant

Note: The criteria specify the population studied (i.e. all French aquatic SES research), the interventions (all SkE approaches involving consultation or collaboration will be considered relevant interventions), the type of publication (i.e. all scientific articles) as well as their publication date (i.e. from 1945 to 2023).

to evaluate SKE effectiveness and to survey involved stakeholders on their perception of participatory approaches and science in general (through interviews and short questionnaires that will be conducted in another study).

To further improve the replicability and transparency, the scripts used for the analyses will be shared on the Github platform (https://github.com).

3 | DISCUSSION

Stakeholder engagement in research projects serves as a bridge between the scientific community and society, facilitating meaningful interactions, collaborative problem-solving, and the co-creation of knowledge. Involving stakeholders in research foster a more democratic and inclusive approach to science, ensuring that scientific progress is aligned with societal values, needs and aspirations. This collaborative approach enhances the overall quality of research, its societal impact, and the public's trust in science.

The systematic map will contribute to provide scientists, but also stakeholders (e.g. policy makers, environmental NGOs as well as other stakeholders from various sectors and territories) a reliable overview and characterization of the SkE approaches conducted so far research projects on aquatic SESs. By pinpointing specific topics, contexts, questions and methods that have been well-studied, as well as areas that require further investigation, the systematic map could guide future research priorities. It will reveal patterns, trends and potential consistencies across different research studies, providing a holistic understanding of how stakeholder have been engaged in research on aquatic SESs. Moreover, the systematic map will highlight best practices and lessons learned by examining the methodologies, approaches and outcomes of research projects which have engaged stakeholders. This guidance could help researchers design and implement more effective SkE processes that maximize the benefits for both science and society. This will help strengthening the science-society relationship and implementing efficient and sustainable SkE processes in future research projects.

TABLE 5 Type of data per category to be extracted from the selected articles.

Category	Type of data
Bibliographic information	(a) Title (b) Publication year (c) Author names (d) Authors affiliations (e) Publication type (f) Publication source (g) Current impact factor of the journal if available (h) Language of the full text (i) Number of citations (j) DOI (k) Article type (e.g. primary research article, review, book chapter)
Information relating to the inclusion criteria	(a) Population: Social-ecological system(s) (e.g. lake, river, coast, lagoon, sea) (b) Population: Location(s) (e.g. Bay of Biscay) (c) Population: Research topic(s) (e.g. climate change) (d) Population: Research sub-topic(s) (e.g. sea-level rise) (e) Population: Research question(s) (f) Population: name of the participatory project (g) Population: Engagement period (e.g. period during which the project was carried out) (h) Intervention: Stakeholder identification method (e.g. stakeholder analysis, random sampling from registration list) (i) Intervention: Stakeholder definition provided (j) Intervention: Stakeholder category (i.e. non-user citizen (retired, etc.), users, decision makers, managers, NGOs, scientists) (k) Intervention: Stakeholder sub-category (e.g. fishers, environmental NGOs, international policy makers) (l) Intervention: Number of stakeholders (per type) involved (m) Intervention: Level of engagement (i.e. information, consultation, involvement, collaboration, empowerment) (sensu Vaughn and Jacquez (2020b)) (n) Intervention: Intention for participation type (e.g. advance of knowledge, analysis, assessment) (o) Intervention: Intention for participation sub-type (e.g. mental models, ideas of alternative livelihood) (p) Intervention: Method(s) used (e.g. meetings, negotiation, interviews) (q) Intervention: Number of interactions (r) Outcome(s): all potentially relevant outcomes
Additional information	(a) Funding (b) Comments

AUTHOR CONTRIBUTIONS

All authors conceived and designed the systematic map protocol. Adrien Chevallier, Heikel Balti and Fabien Moullec drafted the manuscript. Adrien Chevallier, Heikel Balti, Sophie Gourguet, Claire Macher, Yunne-Jai Shin and Fabien Moullec adjusted the methodology, including the inclusion/exclusion criteria that resulted in the final protocol design. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

No data sets were generated or analysed during the current study. Any data used for the full stage 2 report will be made publicly available with that article.

ORCID

Fabien Moullec https://orcid.org/0000-0001-8006-1169

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix S1: ROSES for systematic map protocols. Version 1.0.

Appendix S2: Test list of relevant articles.

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